Chapter 1

Broadband and Fibre Optic Technology

Communication means transfer of information from one person to another. Two persons who are communicating with each other can either be communicating face to face or they can be at a distance apart from each other. Earlier, we used talking drums, chain of beacons and letters as tools of communication to form connections and convey our thoughts over a distance. Now-a-days telecommunication is used to serve the purpose. Telecommunication, also known as telecom, is the transfer of information over large distances by electronic methods like phones, Internet, etc., and refers to all types of voice, data and video transmission. The telecom sector is one of the fastest growing industries in India. India is the second largest telecom market in Asia after China.

BROADBAND INDUSTRY

Broadband communication is considered to have higher transmission speeds and wider bandwidth than that available over a telephone line. Wider bandwidth refers to increased information carrying capacity. It is a term frequently used while accessing the Internet using high speeds, usually higher than 248 kbps (kilo bytes per second). Broadband can be provided via phone line, cable, or satellite. Figure 1.1 shows the different types of broadband communication.

More to know

World Telecommunication Day is celebrated annually on 17th May since 1969. The date marks the anniversary of the founding of International Telecommunications Union (ITU) on 17th May 1865, when the first International Telegraph Convention was signed in Paris. In 2006, the name of the event was changed to World Telecommunication and Information Society Day (WTISD). The purpose of WTISD is to help raise awareness of the possibilities that the use of the Internet and other information and communication technologies (ICT) can bring to societies and economies, as well as of ways to bridge the digital divide.

Fig. 1.2: Internet of Things

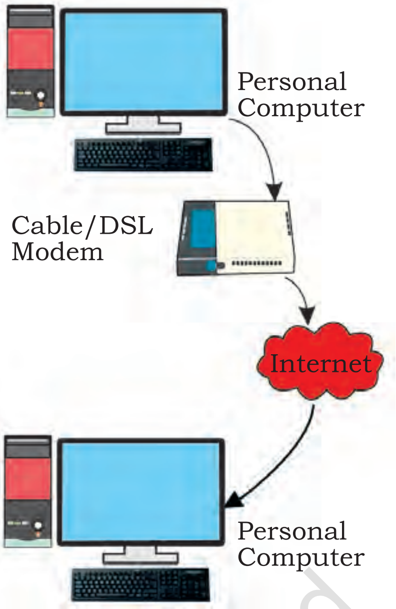

Fig. 1.1: Broadband Communications

Types of broadband

The broadband services can be classified into different types. It includes several high-speed transmission technologies, such as,

1. DSL (Digital Subscriber Line)
2. Cable
3. Fibre Optics
4. Wireless
5. Satellite
6. Broadband over Power Line (BPL)

The broadband technology you choose also depends on a number of factors. Like whether you are located in an urban or rural area. Hence broadband is packaged with other services such as voice, telephone and home entertainment, via Internet.

Global broadband market

Countries around the globe have acknowledged the role of broadband in their economic and social growth. Several countries like the U.S., U.K. and China have shown tremendous progress towards it. For example, United States will have minimum download speed of 25 Mbps and coverage to 100 Million households (>80%) by the end of 2020.

China will have a minimum download speed of 50 Mbps in urban areas and 12 Mbps in rural areas, covering 98 per cent of administrative villages by the end of 2020. United Kingdom will have a minimum download speed of 24 Mbps and a coverage target of 95 per cent. Currently, 151 countries have rolled out ambitious national broadband plans.

Indian broadband market

India has the second highest number of citizens online in the world, accounting for 10 per cent of the world's internet population. It aspires to connect 800 million new citizens by 2020, of which 600 million would be broadband users. Customers would expect a high quality, high speed and high reliability network as they access videos and other high bandwidth applications.

Courtesy: Information from Wisconsin's Broadband Reference Guide produced by—WI Public Service Commission, UW-Extension Madison, and the Center for Community Technology Solutions, January 2014.

Telecommunication

The word telecommunication is derived from a French word *comunicacion*. Tele means 'far off', and communication means 'to share'. It is the exchange of information over large distances by electronic means. It refers to all types of voice, data and video transmission. It includes transmitting technologies like telephones (wired and wireless), microwave communication, fibre optics communication, etc. It consists of two stations, one is equipped with a transmitter and the other with a receiver as shown in Fig. 1.3. The medium of signal transmission can be via electrical wire or cable (also known as copper), optical fibre or the free space transmission known as wireless communication.

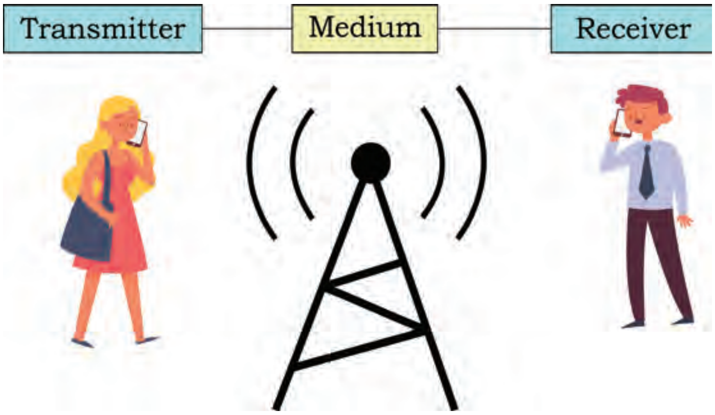

Fig. 1.3: Block representation of telecommunication system

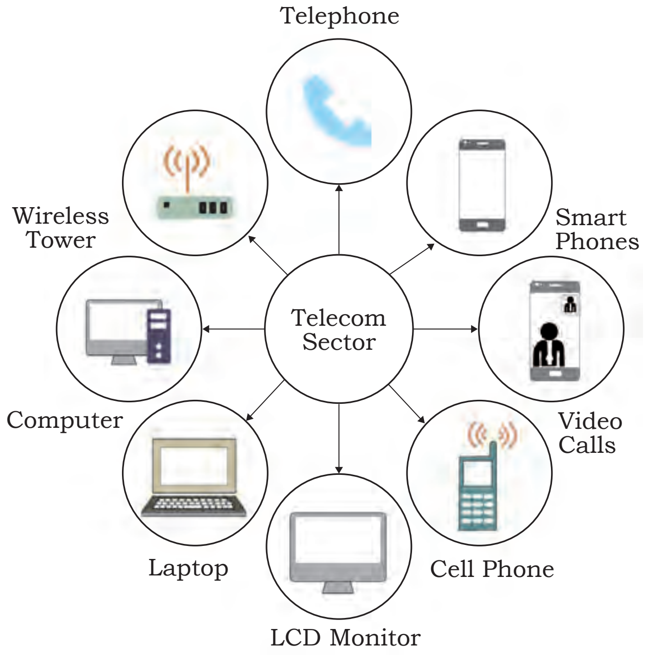

Fig. 1.4: Area under telecom sector

Telecom Sector in India

The Indian telecom industry is active from more than 165 years. Hence telecommunication sector is being greatly affected by the increased globalisation in a positive manner, which in turn has affected the Indian economy. This increase of revenue is the result of increased use of communication technologies in urban as well as rural areas. The various areas of telecom sector include mobile phones, fibre optic communication, broadband communication like access to high-speed internet phones, digital subscriber loops (DSL), satellite communication as shown in Fig 1.4.

Telecom sector has been the fastest growing industry in India with ample number of users. The government of India has generated liberal policies and proactive regulatory framework with an aim to attain rapid growth in this sector. By this growth, the economy of the country has been largely affected. Figure 1.5 addresses the benefits acquired from the Indian telecom industry.

Fig.1.5: Benefits of telecom industry

Indian Telecom Industry

There are many Indian telecom companies promoting the growth of telecom market.

Vodafone

It is one of India's leading telecom service providers. It provides pan India voice and data services across 2G, 3G and 4G platform. It supports the growing demand for data and voice. Hence, it greatly contributes towards creating Digital India.

Vodafone

BSNL

Bharat Sanchar Nigam Limited was developed on 15th September 2000. It provides the telecom services from 1st October 2000. It is one of the largest telecom service in India covering the remote areas. BSNL serves telecom services like Wireline, CDMA mobile, GSM mobile, Internet, Broadband, Carrier service, FTTH, etc.

BSNL

Bharti Airtel Limited

Bharti Airtel Limited is also known as Airtel. It is an Indian-based global telecommunications services company situated in Delhi, India. It provides GSM, 3G, 4G LTE mobile services, fixed line broadband and voice services. It is the third largest mobile network operator in India.

Airtel

Reliance Jio

Jio is an Indian mobile network operator owned by Reliance Industries. Jio does not offer 2G or 3G service, and instead uses digital method to provide voice service on its network. It is the largest mobile network operator in India.

Jio

Optical fibre technology

Fibre optic communication system consists of three main components as shown in Fig. 1.6. These are optical transmitter, fibre optic cable and an optical receiver. The optical transmitter converts electrical signal to optical signal. Fibre optic cable carries this optical signal from the optical transmitter to the optical receiver. Finally the optical receiver reconverts the optical signal to electrical signal.

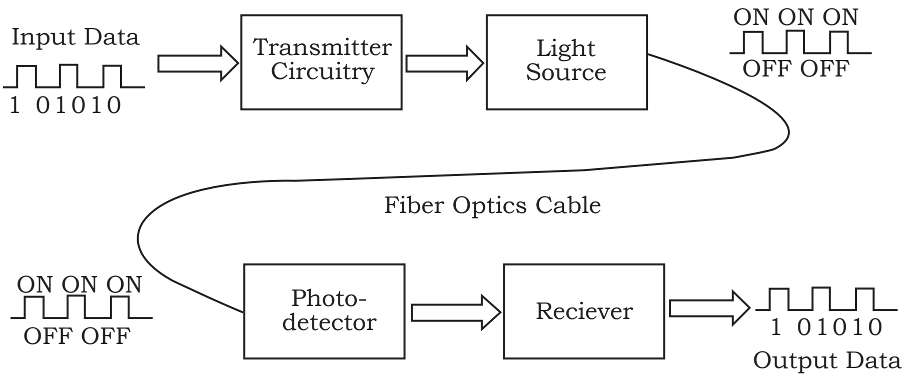

Fig. 1.6: Block diagram of optical fibre transmission system

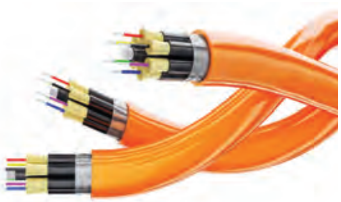

Fig. 1.7: Optical fibre cable

Optical fibre cables are used as a medium for telecommunication and networking because they are flexible and can be bundled as ordinary cables. These are advantageous for long-distance communication, because light propagates through the fibre with little attenuation compared to electrical copper cables. Figure 1.6 shows that all fibre optic transmission systems uses light carrying data to convey information from a transmitter to a receiver.

Fig. 1.8: Signalling lamp for sending the message

Timeline of optical communication

In earlier days light was used for transmitting information from one place to another. In 800 B.C., the Greeks used fire and smoke signals for communicating information like victory in a war, alerting against enemy, calling for help, etc.

During the second century B.C., optical signals were sent using signalling lamps so that any message could be sent (Fig. 1.8). Till the end of the 18th century there was no growth in optical communication and transmission paths were affected by atmospheric effects such as fog and rain.

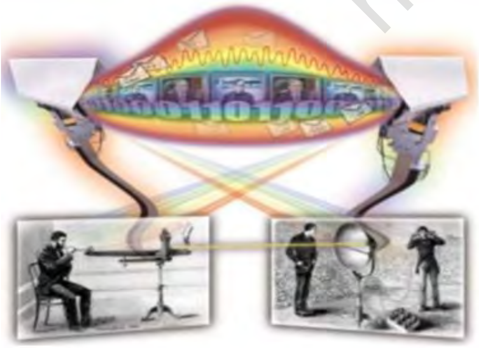

Fig. 1.9: Alexander Graham Bell transmitted his voice as telephone signal

More than a hundred years ago, in 1880 Alexander Graham bell transmitted his voice as a telephone signal through about 600 feet of free space (air) using a beam of light as the carrier. He demonstrated the basics of optical fibre communications. Therefore, he named his experimental device the photophone (Fig. 1.9).

Charles Kuen Kao is known as the father of fibre optic communications for his discovery of certain physical properties of glass in the 1960s, which laid the groundwork for high-speed data communication in the Information Age (Fig. 1.10). Before Kao's pioneering work, glass fibres were widely believed to be unsuitable as a conductor of information because of excessively high signal loss due to light scattering. Kao realised that, by carefully purifying the glass, bundles of thin fibres could be manufactured that would be capable of carrying huge amounts of information over long distances with minimal signal attenuation, and that such fibres could replace copper wires for telecommunication.

Fig.1.10: Charles Kuen Kao performing an experiment

Major breakthrough came in 1970, when Corning Incorporated scientists Robert Maurer, Donald Keck, and Peter Schultz created a fibre with a measured attenuation of less than 20 dB per km. It was the purest glass ever made. In April 1977, General Telephone and Electronics tested and developed the world's first live telephone traffic through a fibre-optic system. They were soon followed by Bell in May 1977, which covered a distance of approximately 1.5 miles (Fig. 1.11).

Fig. 1.11: Major breakthrough came in 1970

Optical fibre market overview

An optical fibre is a transparent and flexible fibre made by drawing glass or plastic, which is used to transmit light. The optical fibre has wide usage in fibre-optic communications, where they allow transmission over longer distances and at higher bandwidths than wire cables. The adoption of fibre optic cables to send signals with less amount of loss of optical signal has increased over the period, which drives the growth of the market.

Role of Fibre Optics in Digital India

Fibre optics will play a critical role in realising the dream of Digital India. The existing fibre-to-the-home (FTTH) is the infrastructure of the 21st century. As per the recent global survey, 71 per cent of subscribers are expected to transition their networks to FTTH by 2025. The combination of fibre and wireless technology will meet the needs for the current and future demands of expanding bandwidth. Under the Digital India initiative, the Indian government is aiming to supply Internet access throughout the whole country, connecting 600,000 rural citizens to bridge the digital gap between cities and villages through a fibre optics network.

More to know

According to the former President of India APJ Abdul Kalam, 400 million fibre km of infrastructure is required in order to form Digital India. As a result, it is obvious that fibre optics will play a critical role in realising the dream of Digital India.

Role of Optical Fibre in Broadband Industry

Optical fibre uses light instead of electricity to carry a signal. Earlier copper cables were used to carry electric data signals. Optical fibre cables are made of glass that reflect light and hence carry the information with high speed across limitless distances.

Advantages of fibre optics broadband connectivity

Fibre optic cables have revolutionised network communication ever since their inception nearly four decades ago. Some of the most popular uses of fibre optic cables are listed below.

Internet

Fibre optic cables are capable to transmit large amount of data at very high speed. Therefore this technology is widely used for Internet. Fibre optic cables are lighter and more flexible than traditional copper wires and carry more data.

Cable television

The use of fibre optic cables in the transmission of signals has grown explosively over the years. These cables are ideal for transmitting signals for high definition televisions, because they have greater bandwidth and speed. Also, fibre optic cables are cheaper as compared to the same quantity of copper wire.

Telephone

Calling telephones within or outside the country has never been so easy. With the use of fibre optic communication, you can connect faster and have clear conversations.

Computer networking

Fibre optic cables are useful in computer networking. Internet speed is increased with the use of fibre optic cables. It enables the transfer of information with high speed across networks.

Surgery and dentistry

Fibre optic cables are widely used in the field of medicine and are an important part of non-intrusive surgical methods, popularly known as endoscopy. In such applications bright light is used to light up the surgery area within the body.

Lighting and decorations

The use of optical fibres in the area of decorative illumination has also grown over the years. Fibre optic cables are widely used in lighting decorations, illuminating Christmas trees, etc.

Mechanical inspections

Fibre optic cables are widely used in the inspection of remote places. Some applications are on-site inspections for engineers and inspection of pipes for plumbers.

Military and space applications

With the high level of data security required in military and aerospace applications, fibre optic cables offer the ideal solution for data transmission in these areas.

Duties of optical fibre splicer

The primary responsibility of the Optical Fibre Splicer is to splice fibre optic cables placed both outdoors and indoors. Optical Fibre Splicer will be responsible for performing activities related to connecting, testing and validating the integrity of new and existing outside plant telecommunication networks. Optical Fibre Splicer should possess skills to properly design, install and maintain fibre optic networks. A splicer uses the latest fibre optic technology and equipment to learn how to do splicing, testing of spliced fibre, and troubleshoot optical fibre networks in order to increase efficiency, reliability and safety as well as reduce cost. The basic duties to be carried out by the optical fibre splicer are —

- Perform cable installation, construction, maintenance and repair works.
- Operate all types of splicing and testing equipment.
- Prepare and maintain splicing records, schematics and diagrams.
- Understand fusion splicing and mechanical splicing.
- Splice overhead, underground or submarine, multiple-conductor cables used in telephone and telegraph communication and electric-power transmission systems.
- Perform work in accordance with industry standards. Maintain the scope of work on the project and adhere to safety procedures.
- Handle responsibility for customer premise installations, including racking, cabling, etc.
- Perform fibre tests with OTDR's, light source and meters.
- Terminate, splice, bonds/grounds and tests fibre optic equipment to division standards.
- Provide accurate equipment location, splicing and terminating records for the fibre database. Assist construction/engineering departments in accepting and turning up the fibre network.
- Ability to solve problems and work independently.
- Strong communication and interpersonal skills.
- Monitor, communicate and perform corrective actions to fix problems affecting any fibre or fibre related equipment.
- Must be well versed in modern fibre splicing techniques.
- Must have experience with equipment like: fusion splicer, mechanical splicer, OTDR, power meters, traffic identifiers, digital multi-meters, cleavers,

strippers, buffer tube splitters, cable ring tools, hand tools.

- Ability to work under minimal supervision. Apply technical expertise to evaluate problems and implementing the best solutions.
- Validate and test end-to-end service provisioning for the cable network.
- Confirms accurate cable terminations on cross connect, patch panels, hubs, and routers.
- Review site surveys, condition discrepancy reports, design drawings, technical manuals for cable installation feasibility.
- Maintains safe and secure work environment by complying with government standards and legal regulations.

Optical fibre splicer – Knowledge, skills, and abilities

The optical fibre splicer should possess the following technical knowledge, skills and abilities to perform the splicing job with precision.

- Knowledge of fusion splicing.
- Ability to work with clients regarding engineering problems, confer with customer contacts while communicating with the outside plant supervisor.
- Ability to pay close attention to detail and make good decisions based on information given.
- Ability to multitask and stay organised under pressure.
- Possess knowledge in all types of splicing activities, cable and safety test equipment and use of all types of cable construction equipment.

Check Your Progress

A. Multiple Choice Questions

1. Broadband refers to ____________.
   (a) wide band of frequencies
   (b) narrow band of frequencies
   (c) large number of channels
   (d) less number of channels

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2. Broadband provides the data rate in ________________.
   (a) Kbps (Kilo bits per second)
   (b) Mbps (Mega bits per second)
   (c) Bps
   (d) 56 bps
3. Broadband describes the future of ______________ communications.
   (a) digital
   (b) analog
   (c) pulse mode
   (d) saw-tooth
4. Digital Subscriber Line or DSL is a communication medium used to transfer digital signals over _________.
   (a) television
   (b) computer
   (c) mobile phones
   (d) standard telephone lines
5. India is the world's fastest growing industry in the world in terms of a number of wireless connections after_____.
   (a) China
   (b) Japan
   (c) America
   (d) Europe
6. Which of the following organisations is meant to regulate tariffs and policy making?
   (a) TRAI
   (b) MTNL
   (c) BSNL
   (d) AIRTEL
7. Fibre optics will play a critical role in realising the dream of ______________ India.
   (a) analog
   (b) digital
   (c) modern
   (d) traditional
8. Broadband over Powerline (BPL) is the delivery of broadband over the existing _______________.
   (a) low and medium voltage electric power distribution network
   (b) medium voltage electric power distribution network
   (c) low voltage electric power distribution network
   (d) power distribution network

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9. Optical fibres are widely used in fibre optic communications, which permits transmission over other forms of communication through ______________.
   - (a) longer distances and at higher bandwidths (data rates)
   - (b) short distances and at higher bandwidths (data rates)
   - (c) longer distances and at narrow bandwidths
   - (d) less distances and at narrow bandwidths
10. Which of the following methods was used in 800 BC., by Greeks for sending information like victory in a war, alerting against enemy, call for help, etc.?
   - (a) Fire and smoke signals
   - (b) Electrical signals
   - (c) Wireless signals
   - (d) Transmission media
11. Which of the following equipment is needed to allow home computers to connect to the Internet?
   - (a) Modem
   - (b) Gateway
   - (c) Monitor
   - (d) Peripheral
12. The server on the Internet is also known as a __________.
   - (a) hub
   - (b) host
   - (c) gateway
   - (d) repeater
13. Which of the following is true in the context of modems?
   - (a) Digital signal is amplified.
   - (b) Several digital signals are multiplexed.
   - (c) A digital signal changes some characteristic of a carrier wave.
   - (d) None of the above
14. World Wide Web pages can be described as multimedia pages. This means that the pages may contain _________.
   - (a) text, pictures, sound
   - (b) text and pictures only
   - (c) video clips, sound, text, pictures
   - (d) None of the above

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B. Fill in the Blanks

1. Primary responsibilities of the optical fibre splicer is to splice ___________.
2. Satellite broadband is another form of ____________ broadband, and is also useful for serving remote or sparsely populated areas.
3. Optical fibre technology converts an ________signal to a _________ signal for the purpose of granting access to broadband Internet.
4. The highest data rate is provided by _________ medium.
5. Transmission media are usually categorised as _____________, ___________ and __________.
6. ______________ transmission mode is used for data communication along telephone line.
7. For carrying digital data over long distance using either analog signal or digital signal at approximately spaced points, we must have _____________.

C. State whether True or False

1. A server can run on a workstation computer.
2. Optical fibre communication is a high speed broadband communication technology.
3. In a peer-to-peer network, any client computer can also be a server.
4. Today fibre-optic cable is the media of choice for backbone networks.
5. Optical fibre is only used for wireless communication.
6. A wireless network access point is a device that allows computers to access a wired network using radio waves.
7. A telephone modem is a device that connects your computer to your phone line so that you can access another computer or network.
8. Wireless communications media transmits information over a closed, connected path.
9. A repeater is a device that receives a radio signal, strengthens it, and sends it on.
10. Bandwidth refers to the capacity of the communications line.

D. Answer in one Sentence

1. What is the full form of TRAI?
2. What are the components of telecommunication?
3. What is broadband?
4. List the various broadband technologies.
5. How does broadband work?
6. What is meant by the term Telecommunication?

7. List out the various telecom industries in india?
8. What is the job of a splicer?
9. List the components of fibre optics communication technology.

E. Short Answer Questions

1. Discuss the evolution of fibre optics.
2. What is the role of fibre optics in the broadband industry?
3. Discuss the role of splicer in the fibre optics market? Why is splicer required?
4. What is broadband? State the different types of broadband.
5. What are the major telecom companies in India?
6. How does fibre optics technology work?
7. What do you mean by wired communication?
8. What are the advantages of fibre broadband connectivity?
9. Discuss the Indian broadband market.
10. What kind of knowledge is required by optical fibre splicer?

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